

DOCUMENT RESUME

ED 290 742

SP 029 869

AUTHOR Rockler, Michael J.
 TITLE Improving the Knowledge Base in Teacher Education.
 PUB DATE [87]
 NOTE 26p.
 PUB TYPE Viewpoints (120)
 EDRS PRICE MF01/PC02 Plus Postage.
 DESCRIPTORS *Behavioral Objectives; *Behaviorism; Behavior Modification; *Brain Hemisphere Functions; *Cognitive Psychology; Cognitive Restructuring; *Educational Research; *Learning Theories

ABSTRACT

Education in the United States for most of the last 50 years has built its knowledge base on a single dominating foundation--behavioral psychology. This paper analyzes the history of behaviorism. Syntheses are presented of the theories of Ivan P. Pavlov, J. B. Watson, and B. F. Skinner, all of whom contributed to the body of works on behaviorism. A brief outline is presented of four competing interest groups, each attempting to to define curriculum: the humanists, the developmentalists, the social meliorists, and the social efficiency educators. In the second section of the paper, the views of a number of critics of behaviorism as a psychological perspective and as the source of the knowledge base in teacher education are examined. These critics include Richard M. Restak, Arthur Koestler, Bertrand Russell, Bruno Bettelheim, Elliot Eisner, and Leslie Hart. The final section of the paper presents alternative sources for the knowledge base. The works of Bertrand Russell and Karl Popper are discussed, and the prospect for conceptualizing learning offered by recent research on the hemispheres of the brain is appraised. (JD)

 * Reproductions supplied by EDRS are the best that can be made *
 * from the original document. *

IMPROVING THE KNOWLEDGE BASE IN TEACHER EDUCATION

Michael J. Rockler

Rutgers University

Camden, New Jersey 08102

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

M. J. Rockler

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

- ☐ This document has been reproduced as
received from the person or organization
originating it.
- ☐ Minor changes have been made to improve
reproduction quality.

- Points of view or opinions stated in this docu-
ment do not necessarily represent official
OERI position or policy.

INTRODUCTION

The transmission of each generation's accumulated knowledge to its children is perhaps the most significant endeavor of society. The instruction of young people has its roots in a rich tradition. Educational theorists have been among history's greatest intellects.

In ancient Greece both Plato and Aristotle were interested in the process of schooling. They each established academies of higher education which offered students specific ideas about teaching. Plato outlined a life-long curriculum while Aristotle offered advice on instructional strategies still valid today.

The Middle Ages was also an important period for the development of educational theory. Scholastics like Peter Abelard and Thomas Aquinas focused attention on teaching and learning. They provided insight into both curriculum and methodology.

The Renaissance produced many educators including Erasmus and Comenius. The period known as the Reformation saw religious leaders like Calvin and Loyola refine means of using education in the attainment of their goals. Some of Loyola's techniques still influence the nature of teaching in

many schools and the effect of the Calvinists on American education has been enormous.

The Enlightenment ideas of John Locke strongly influenced Thomas Jefferson's writing of the Declaration of Independence. Locke's views on teaching also affected education in Europe and the United States. Rousseau's view of nature influenced a host of nineteenth century educational reformers including Pestalozzi and Froebel. During the nineteenth century, Maria Montessori developed her ideas and John Dewey began his career as an educator and philosopher.

Schools in the United States have lately been the targets of much criticism. The year 1983 saw a host of calls for reform including Ernest Boyer's High School, A Nation at Risk and the organization of the Holmes Group. The general consensus is that education in the United States needs improvement. However, many of the recent plans for reform seek quantitative changes: more years of math, science and English for pupils, more hours of liberal arts study for teacher education students as well as more dollars for salaries and programs.

The changes called for will certainly not harm education and will probably help to improve many aspects of schooling. But demands for quantitative reform are symptomatic of a deeper, more fundamental problem in education: the need to improve the knowledge base.

Despite its rich historical antecedents, despite a long history of educational theorists who have offered a wide variety of potential solutions to the problem of schooling, education in the United States for most of the last fifty years has built its knowledge base on a single dominating foundation--behavioral psychology. Some of the problems in education today

result from the narrowness of that base. This paper will analyze the history of behaviorism. It will present the views of a number of critics of the knowledge base. Finally, it will conclude by offering alternative sources for establishing an improved basis for knowledge about teacher education.

BEHAVIORISM

Stephen Jay Gould, in The Mismeasure of Man (4), indicates that in the early nineteenth century, psychology was considered a "soft science, if a science at all." Early psychologists wished to demonstrate that the science of human behavior could be as rigorous as physics. They attempted to establish this through the quantification of the discipline. This perspective shaped American psychology more than any other outlook. Education--also seen as a soft science--sought a rigorous approach to knowledge as well. Since teaching is more difficult to analyze than other kinds of behavior, educators employed measurement to an even greater extent than the psychologists. Both groups found the road to respectability in the scientific method and in the development of behaviorism.

The basic premise of behaviorism can be found in the connection between stimulus and response. Though modern behaviorists offer a more sophisticated variation of this relationship, it remains the central construct of this perspective.

In many ways, Aristotle was a forerunner of modern behaviorism. He believed that human behavior was governed by the same empirical laws which

governed the rest of the universe. These principles could be discovered through the process of induction--the study of specific cases in order to create universals.

Modern behaviorism arose as part of the general development of science which began in the later Renaissance and grew during the age of Enlightenment. At this time in the history of thought, early empiricists discovered that the universe was governed by laws which could be understood by a rational process called the scientific method. The extreme objectivism of behaviorism--that only externally observed behavior exists--is a legacy that comes from the experimental science that began in ancient times with Aristotle and reached its greatest development in the eighteenth century.

The stimulus-response bond was strengthened by the development of physics which objectively studies processes in the physical world. In a sense, the S-R bond is a psychological restatement of Newton's law that for every action there is an equal and opposite reaction. It is ironic to note that behaviorism, which sought to mold psychology in the image of physics, maintains that only observable behavior can be studied while physics now holds that the most important processes in the universe are unseen ones that must be inferred.

An early psychologist whose work led to the development of behaviorism in its modern form was the Russian researcher Ivan P. Pavlov (1849-1936) who created the concept of classical conditioning--a forerunner of the S-R bond.

Pavlov worked with hungry dogs who were chained to tables; these animals had small wholes cut in their throats so that Pavlov could accurately measure salivation. A starving dog viewed a piece of meat and his natural response was to salivate. Pavlov labeled the food the unconditioned stimulus and

the salivation he called the unconditioned response. This was "unconditioned" because any hungry animal creates saliva at the sight of food. Pavlov then rang a bell each time the food was shown to the animal. The dog, seeing the meat when he heard the bell, made the same response. Then Pavlov removed the meat and simply rang the bell. The dog learned to produce saliva at the sound of the bell even though no food was present. Pavlov called the bell the conditioned stimulus and the salivation at the sound of the bell became the conditioned response.

A major American behaviorist, John B. Watson (1878-1958), earned his Ph.D. at the University of Chicago in 1903. There he studied white rats to prepare his doctoral thesis. This encouraged the experimental use of rodents in psychology; it led to behaviorism's somewhat negative label of "rat" psychology. In 1908 Watson joined the faculty of Johns Hopkins University in Baltimore where he created an animal laboratory for the study of psychology. Watson's work at Hopkins established behaviorism as a separate school.

For Watson the subject matter of psychology was human and animal behavior. Its goal was to predict, discover the laws of, and ultimately control behavior. Watson formulated the position that only overt behavior, and not consciousness, was a legitimate study for scientific psychology. This led to a denial of the study of consciousness and sometimes even its existence. Watson took the extreme position that thought was verbal behavior--subvocal speech consisting of minute movements of the vocal cords. (Watson eventually left academia to become an executive in a Madison Avenue advertising firm.)

The behaviorist who has most influenced education is B.F. Skinner (1904-). He revised Pavlov's paradigm of classical conditioning to create operant conditioning. Skinner studied pigeons by placing them in boxes. A hungry pigeon

learned to press a lever which released a pellet of food. Pressing the lever consisted of the response and food represented the stimulus. In this way Skinner reversed classical conditioning and created a very popular approach to education.

An important Skinnerian concept which has greatly affected education is reinforcement--a mechanism derived from psychologist E.L. Thorndike's law of effect. Thorndike had argued that learning occurs as a result of an association between a stimulus and a response. When the S-R sequence is followed by satisfaction, the association is strengthened and learning takes place. Skinner redefined Thorndike's construct by labeling as a reinforcer anything that increased the likelihood of a response. Anything added to the situation which increased the likelihood of a response is a positive reinforcer. Its absence is negative reinforcement. The concept of punishment--the addition of a negative reward--was not devised by Skinner. None-the-less, the use of punishment to eliminate undesirable behaviors is a distortion of behaviorism that has entered education in many settings.

Extinction is another behavioral concept defined by Skinner. It shapes action by removing a response rather than creating one. Unwanted behavior disappears when it is not reinforced. Education based on Skinner's model becomes a system where desired behaviors are shaped by positive reinforcement and negative behaviors are extinguished by the lack of reinforcement. Punishment--the use of negative reinforcers--is not a necessary part of the model.

Reinforcers can also be used to help students to discriminate--an important concept for behaviorism. Discrimination is the ability of a student to choose among multiple stimuli in order to find the correct response. This

construct is significant because it allows the behaviorist to account for concept formation independent of consciousness and the existence of insight.

Behaviorists define learning as a relatively permanent change in behavior.

Although behaviorism is no longer as popular in psychology as it once was, it continues to have great appeal to educators. It has inspired instructional planning based on behavioral objectives--an approach most strongly advocated by educational psychologist Robert Mager.

A behavioral objective is a statement which describes an outcome. It communicates the instructor's intent and indicates what the learner will be doing when demonstrating his or her achievement. It also describes the criteria for judging adequate performance. Mager argues that instructional objectives should be written for every aspect of a lesson and that every educational intent must be specified by a behavioral objective.

Behavioral objectives have come to dominate the organization of instruction in recent years. They appeal to administrators and supervisors because they can easily be measured and because they are relatively simple to write. Anyone who wishes to teach in contemporary schools must learn how to use them. However, not all outcomes can be described in behavioral terms. This has sometimes resulted in the avoidance of certain kinds of objectives, particularly in the fine arts, where behavioral objectives are difficult to compose. Yet the ubiquitous nature of behavioral objectives and the success achieved by those who advocate them in virtually eliminating the consideration of other kinds of objectives indicates the way in which behaviorism has come to be the central focus of the knowledge base in education.

In 1957, Herbert M. Kliebard, a professor of education at the University

of Wisconsin, published The Struggle for the American Curriculum 1893-1958. (7) In it he identifies four competing interest groups, each of which attempted to define curriculum in the United States during this period. First he cites the humanists, represented by Charles Eliot--president of Harvard University. This group saw themselves as the "guardians of an ancient tradition tied to the power of reason and the finest elements of the Western cultural heritage." The humanists supported a classical approach to curriculum--traditional courses in science, mathematics, the humanities and languages of all types including Greek and Latin.

A second interest group Kliebard calls the developmentalists. They argued that the natural development of the child ought to be the basis of curriculum. This group held that scientific study of the stages of child development would define what children were ready to learn; this data would help shape the program of studies. Generally, the developmentalists believed in minimal intervention, seeking to help each child learn naturally through the unfolding of intellect.

The 'social meliorists made up a third force attempting to influence curriculum. This group saw the schools as the principle agent for social change. They desired the social reconstruction of society through education. The social meliorists believed that the corruption of the city, of politics, and of the economy could all be remedied through education.

The final interest group identified by Kliebard are the social efficiency educators. They sought to use science to create a smoothly functioning society. These educators saw teaching as a science based on exact measurement and precise standards. They sought a predictable and orderly world. The social efficiency educators supported the testing movement; they saw the development

of the concept of intelligence quotient as a major advance in education.

John Franklin Bobbit, according Kliebard, best represents the social efficiency educators. In 1918 Bobbit published a book entitled, The Curriculum

(2). A paragraph from it demonstrates the nature of this group:

The central theory is simple. Human life, however varied, consists in the performance of specific activities. Education that prepares for life is one that prepares definitely and adequately for these specific activities. However numerous and diverse they may be for any social class, they can be discovered. This requires only that one go out into the world of affairs and discover the particulars of which these affairs consist. These will show the abilities, attitudes, habits, appreciations, and forms of knowledge that men need. These will be the objectives of the curriculum. They will be numerous, definite, and particularized. The curriculum will then be that series of experiences which children and youth must have by way of attaining those objectives. (p. 42)

The four interest groups identified by Kliebard have all affected education. All of them have influenced curriculum to some extent. The social efficiency educators, however, became the dominant force in teacher education. This group quickly adopted behavioral psychology as its position on learning. The combination of social efficiency as a curriculum goal with behaviorism as a learning theory contributed to the domination of behaviorism as the base of knowledge for teacher education.

CRITICS OF BEHAVIORISM

Many persons have opposed behaviorism both as a psychological perspective and as the source of the knowledge base in teacher education. Richard M. Restak, a medical doctor who has published extensively on research about the human brain, makes the following point:

But is behaviorism a sensible level of organization in which to explain the complexities of human behavior? There are several reasons that make this unlikely.

For one thing, behaviorism dodges the most difficult questions about behavior. How do our brains inform us of reality guide our perceptions, formulate our desires and help us to reach our goals? The behavioral psychologist reading the previous sentence would be tearing his hair out at this point in response to some of the the words I used. "Inform," "guide," "desires," "goals"--to the behavioral psychologist such words are meaningless; in fact, more than meaningless, since they represent processes which either don't exist or are unnecessary in explaining behavior. I think such an orientation is more appropriate for studying machines rather than living organisms. (10, p. 24)

Another critic is writer Arthur Koestler. In The Ghost in the Machine (8), he argues strongly against behaviorism, calling it "the dehumanization of man" and a "flat earth view of mind." Koestler says that while humans have often proposed anthropomorphic views of rats, behaviorism has created a "ratomorphic" view of man. He argues that much of human behavior is unpredictable. Quantum physics, he argues, recognizes the unpredictability of aspects of inanimate nature but behaviorists refuse to recognize this about human beings. Koestler writes:

It is impossible to arrive at a diagnosis of man's predicament--and by implication at a therapy--by starting from a

psychology which denies the existence of mind, and lives on specious analogies derived from the bar-pressing activities of rats. The record of fifty years of ratomorphic psychology is comparable in its sterile pedantry to that of scholasticism in its period of decline, when it had fallen to counting angels on pin-heads--although this sounds a more attractive pastime than counting the number of bar-pressings in the box. (p. 18)

Philosopher Bertrand Russell wrote two important books about education, and in both he demonstrated an uneasiness with behaviorism. In Education and the Good Life (11), Russell accepted the need for praise and blame as teaching tools but he opposed the use of corporal punishment because it led to brutality and cruelty.

Between the writing of his first book on education and his second Education and the Social Order (12), Russell and his wife Dora started Beacon Hill, a private school located in England. As a result of operating this institution, Russell gained practical experience with education; this is reflected in his second volume. During this time, Russell also became better acquainted with the developing psychoanalytic perspective.

Russell's experience with Beacon Hill and his reading of psychoanalytic literature resulted in his becoming a critic of behaviorism. He recognized the importance of emotion in learning and he thought it was necessary to examine the ways in which repressed feelings affect action. Russell argued in Education and the Social Order that conditioning is not an effective way to develop character.

In Freud and Man's Soul (1), Bruno Bettelheim describes the ways in which Freud's works have been mistranslated in the United States. Bettelheim explains this, in part, by the fact that the medical profession controls psychoanalysis in America; it also occurred, he argues, because of behaviorism.

Bettelheim reports that Freud had little interest in how his work was being misinterpreted in the United States. He attributes this to Freud's dislike of American culture which he found too materialistic and overly committed to technology. But Freud's strongest aversion to the United States stemmed from the dominance of behaviorism. Bettelheim writes:

In the chapter of An Outline of Psychoanalysis entitled "Psychical Qualities," Freud wrote, "The starting-point for this investigation is provided by a fact without parallel, which defies all explanation or description--the fact of consciousness. Nevertheless, if anyone speaks of consciousness, we know immediately and from our most personal experiences what is meant by it." To this statement he appended a footnote that neither the text nor the context required: "One extreme line of thought, such as the doctrine of behaviorism which originated in America, believes it possible to construct a psychology which disregards this fundamental fact!" Freud was disgusted by a civilization that could explicitly deny the phenomenon of consciousness. (p. 79)

The Educational Imagination (3), a book by curriculum theorist Elliot Eisner, contains a cohesive argument against curricula based on behaviorism. Eisner argues for the replacement of behaviorism in the knowledge base with what he calls the "aesthetic perspective." He holds that teaching is at least as much art as it is science--a perspective at variance with the social efficiency-behavioristic structure of the knowledge base. Eisner makes his point dramatically when he writes (p.16): "In our professional culture a pound of insight is not worth an ounce of data."

Eisner analyzes the consequences of behaviorism on education. First, it has meant that scientific inquiry based on measurement has become the only legitimate way to obtain knowledge about education. This excludes other ways

of knowing and it avoids problems that cannot be scientifically measured.

Second, Eisner argues that educational research has been dominated by the notion of control. This results in the diagnostic-prescriptive model of the classroom which can lead teachers to being rigid in relating to students.

Third, education has become preoccupied with standardized outcomes, leading to heavy reliance on testing in all aspects of the educational process. Teacher education is increasingly affected by scores on the National Teacher's Examination even as performance on the Scholastic Aptitude Test has affected admission into college.

Fourth, it has become nearly impossible for students to participate in the formation of goals. Eisner argues that this is so because these kinds of outcomes cannot be standardized and cannot be controlled.

Finally, behaviorism has led to the tendency to reduce all tasks into small segments. The result of this, Eisner maintains, is to make much of education meaningless to children.

Finally, Eisner writes:

...one is struck by the sober, humorless quality of so much of the writing in the field of curriculum and in educational research. The tendency toward what is believed to be scientific language has resulted in an emotionally eviscerated form of expression; any sense of the poetic or the passionate must be excised. (p. 20)

Another critic of behaviorism in education has been Leslie Hart, whose work on brain compatible teaching represents an alternative to behaviorism. In several books (5, 6), Hart has argued that behaviorism is not a brain compatible

learning theory. One quotation from Hart's work provides a sample of his critique of behaviorism:

Learning in humans can readily be blocked, impeded, discouraged, or fostered, facilitated, encouraged--as we hardly need a specialist to tell us. But the one thing we don't have to do is motivate.

If we weren't motivated by a billion years of evolution to be learners, a few of us would be fossils of an extinct species and the rest of us would never have been conceived.

"Cognito ergo sum," wrote Descartes, two centuries before Darwin--speaking truer than he knew. Were he alive today, he might well have changed that famous observation to "we think, therefore we have survived." (5, p.35)

For Hart, motivation is an erroneous concept, an idea much used in education which has resulted from education's strong connection to behaviorism. Others have also criticized the concept of motivation but it remains a significant term in educational discourse.

Other writers have opposed behaviorism as well. Those described here represent a sample of many who have made similar arguments. These writings indicate the need to seek alternative sources for the knowledge base in teacher education.

ALTERNATIVE SOURCES FOR THE KNOWLEDGE BASE

Alternatives for improving the knowledge base can be found in many places. The introduction to this paper described some of the rich historical

antecedents of education; some of these remain valid perspectives on teaching. A second source of improvement is philosophy. This section will examine the work of Bertrand Russell and Karl Popper--thinkers whose ideas can improve the knowledge base in teacher education. Perhaps the most promising prospect for conceptualizing learning is recent research on the brain. This too will be introduced here.

Bertrand Russell

Bertrand Russell applied his exceptional talents to a great variety of problems in his long lifetime. Some were major interests of his that resulted in seminal contributions to the development of western thought. Russell's work in mathematics and logic are examples of these significant achievements. Other interests involved lesser commitments and resulted in fewer writings. Russell's work on education fits this second category. While an extensive analysis of Russell's work in education is beyond the scope of this paper, it should be noted that he and other philosophers have provided ideas about teaching which should receive greater focus in the development of education's knowledge base.

Russell, in Education and the Good Life (12), offers a perspective about the aims of education. Despite the fact that more than sixty years have passed since Russell formulated these ideas, they still have some validity for the present.

The aims of teaching and learning, Russell argues, are clear. The purpose of schooling should be to produce certain necessary characteristics in men as

well as in women (the inclusion of women was advanced for 1926). It is the development of character that is the most important purpose of education. Russell identifies four qualities that must be included in character formation. These are: vitality, courage, sensitiveness, and intelligence.

Vitality, Russell argues, is a physiological rather than a mental trait and it relates to the joy of feeling alive. Vitality heightens pleasure and diminishes pain. It promotes interest in the world and it also encourages hard work. Vitality is a quality that all men and women should possess; it is a legitimate outcome of schooling.

The second aim of education is the promotion of courage. This quality has two parts. The first Russell defines as the absence of fear. The second aspect of courage is the ability to understand one's own limits. This is an interesting proposition to which Russell devotes considerable space.

The third quality needed for the development of character is sensitiveness. This Russell defines as appropriate responses to particular emotional events in life. Sensitiveness includes sympathy and the ability to respond to abstract injustice as well as to concrete examples of wrong-doing. Truly sensitive people, Russell believed, could not tolerate the cruelties of industrialism even though they had had only vicarious exposure to them.

Finally, Russell stresses that character includes intelligence. Russell's conception of intelligence offers a useful perspective for modern teachers. He makes an important distinction between acquired knowledge (with which intelligence is generally equated as in IQ tests or SAT scores) and what he calls the aptitude for acquiring knowledge. The truly intelligent person is the one who knows how to learn. Russell also states that curiosity about general propositions rather than interest in specific facts is a concomitant of

intelligence. It also includes the ability to think for oneself.

Karl Popper and Fallibilism

The philosophy of fallibilism, developed by Karl Popper, is a response to the problem of induction in philosophy. The inductive principle, on which much of scientific thinking has been based, relies on previous experience to predict future events. This, however, has its limits. Faith in induction was weakened when Albert Einstein's formulations essentially destroyed Newtonian physics. Fallibilism is an attempt to obtain scientific knowledge without relying on induction.

Popper rejected the principle of induction. For him, science does not seek truth but falsity. The purpose of science is to demonstrate the falsity of theories. The scientist proceeds to identify error and does so by employing the critical method. S/he creates a new theory and then proceeds to falsify it. Understanding the fallibility of any notion means that the ultimate task of science is not to establish certainty but to seek improvement. Each step along the way provides a better, more accurate idea; it leads along a road to understanding but, Popper argues, this path never comes to an end.

Henry Perkinson (9, 13) and several of his colleagues at New York University have applied Popper's work to education. For the educational fallibilists the primary purpose of education is improvement. In order to become effective, Perkinson argues in The Possibilities of Error (9), schools should seek the improvement of ideas since all notions are fallible. This is true because all

scientific knowledge will ultimately be falsified and replaced with better, more accurate theories. Improvement comes from constantly attempting to rectify error.

To attain improvement, Perkinson suggests the use of critical dialogue. This differs from discussion or debate because persons seek not victory but improvement. The participants in a critical dialogue avoid dogmatism and confrontation. They advocate not true ideas but ones that are potentially wrong and in need of criticism.

Perkinson and his colleagues have much to offer educators who wish to improve the knowledge base in teacher education by applying the fallibilistic philosophy of Karl Popper.

Research on the Brain

The most promising developments for improving the knowledge base come from recent research on the brain. Understanding its nature can offer educators insight into what writer Leslie Hart calls "brain compatible teaching." Understanding learning based on the nature of the brain can lead to improvement in teaching and learning in ways not previously imagined. It can also indicate which learning theories and teaching techniques are brain compatible and which are not.

After millions of years of evolution, the human brain probably reached its present form by the year 40,000 B.C. The brain, a tremendously complex organ, weighs only three pounds and contains somewhere between thirty billion

and one hundred billion nerve cells (called neurons); these are supported by perhaps another hundred billion glial cells. Neurons do not quite touch each other; they communicate by electro-chemical charges along fibers called dendrites and by endings called axons which make a connection known as a synapse.

The brain consists of three clearly identifiable segments. This has led Dr. Paul MacLean, Director of the Laboratory of Brain Evolution and Behavior at the National Institute of mental health, to label it the "triune" brain. Each of the parts plays a significant role in the preservation of human life and each represents a separate stage in human evolution. The three sections include the reptilian brain (also called the brainstem), the paleomammalian brain (also called the limbic system), and the neomammalian brain (also called the cerebrum).

The brainstem, the oldest segment of the brain, evolved some 500 million years ago. It controls basic bodily functions and maintains the alertness of the organism. The brainstem is the source of routine, habitual behavior.

Attached to the rear of the brainstem is the cerebellum, sometimes called the "little brain." It has increased considerably in size during the course of evolution; the cerebellum provides coordination and posture.

The paleomammalian brain (or limbic system) is the seat of human emotion. It evolved about 250 million years ago and is the part of the brain most highly developed in non-human mammals. The limbic system contains the hypothalamus and the pituitary gland. The hypothalamus (called this because of its proximity to the thalamus, which is located in the cerebrum and is the master control switch of the entire system) regulates several significant behaviors including eating, drinking, sleep, body temperature and other important functions. The hypothalamus also monitors the pituitary gland--the

most important of the body's glands.

The largest part of the human brain is the cerebrum. It contains two hemispheres connected by a set of nerve fibers called the corpus callosum and covered by a layer of nerve cells called the cortex. The cerebrum contributes most to making persons human because it is the source of human reason. With its two hemispheres, it contains both the ability to analyze and the ability to intuit.

Leslie A. Hart has studied brain research and applied it to an understanding of human learning. He calls his approach "proster theory" (the term comes from combining the two words 'program' and 'structure'). The brain has a huge number of prosters; each one contains programs--repositories of learning that has taken place. When one reads a book, for example, a variety of programs come into play, all part of the reading proster. In order to learn, new programs must be added to existing prosters. Hart maintains that new understandings cannot occur unless a proster supporting it is already in place.

Hart likens the proster system to a jukebox. He writes:

But now consider a jukebox, that usually garish monster, which presents us with a choice of many programs. A large one can by ingenious mechanisms select any one of a hundred records, position it, and play that program. The programs it can choose from in response to instructions form a group with a good many features in common. All provide aural entertainment by music, voice or both together. All are in the jukebox, presumably because they are suitable for use in the particular setting. Broadly, they serve the same purpose. Yet there may be good reason for a patron to select one rather than another--to hear one that is gay, or romantic, or suited to another mood, or to have music for dancing, and so on.

The jukebox represents a group of programs that are of a kind, all for the same broad purpose, yet offer alternatives because one may be more appropriate than others to a particular need at a particular moment. We can conveniently call this

arrangement a "program structure"--or still more conveniently, compress that to a "proster." As a new word, proster happily will not carry old associations or meanings. (5, pp. 73-74)

Hart insists that teaching strategies must take into account the nature of the human brain; he argues that most approaches to teaching and learning have failed to do this. Almost nowhere in the training of teachers, for example, is any attention paid to the nature of the human brain. This situation, Hart says, must be rectified if learning is to be effective.

To explain the need for brain compatible teaching, Hart uses an effective metaphor. He argues that fingers of a human hand can easily bend forward but not backward. So too, the human brain can function comfortably in some ways but not in others.

As indicated above, the limbic system is the source of human emotion. It controls what neuroscience calls the four f's: feeding, fighting, fleeing and sexual intercourse. When frightened, the human brain relies on the limbic system to deal with its fear. It "downshifts" and the ability to reason becomes inoperative while the emotional responses of the limbic system come to the fore. Thus when a teacher intimidates a student having difficulty in the classroom, s/he may cause downshifting to occur, forcing the paleomammalian brain to take over; the student temporarily loses his or her ability to reason--a result precisely the opposite of that intended by the instructor.

For Hart, human behavior depends on a two-step cycle. First, one chooses a program (which exists in the brain having been learned at an earlier time) and then one puts it into effect.

Hart indicates that the concept of proster is a model describing how neurons work. He says:

The proster described is a model, not a localized physical structure in the brain. It is put forward not as a neurological diagram but purely as a useful concept. What I have labeled a "switching device" does express the effect produced by neurons in comparisons, such as decision making based on sight-sound, feel-smell, or multisensory inputs. Since different areas of the brain's cortex specialize in handling different sensory inputs, it follows that at least major prosters will not be localized, but instead are networks reaching into many regions of the cortex and in at least some cases, into older gray matter. Prosters then may be thought of not only as the basic thinking apparatus, but also as the networks that, so to speak, tie the brain together. (5, p.76)

Learning for Hart is a building block process. In order to extend the program structures in human brains, previously learned prosters must exist on which to build. Since new prosters must be constructed on old ones, some prosters must be wired into the organism at birth. This is indeed the case. All creatures obtain some program structures within their genes. As Carl Sagan has pointed out, both the genes of an organism and its brain contain information. Intelligence in a species increases at the point where more knowledge is contained in the brain than in the genes.

An important implication for teaching follows: new knowledge must be built on old. When a student is confronted with material for which s/he has no existing proster, s/he will be unable to learn the new concepts. Sometimes when a student stops listening to a presentation and looks out the window, it is because s/he has a proster available for understanding what s/he sees outdoors and does not have one to integrate what the teacher is saying.

Proster theory is a metaphorical construct. It holds that a proster, which is a multiple switching device, can represent the workings of the brain--the

ability of neurons to interact along dendrites and axons creating electro-chemical synapses. Because the number of neurons is so large and because their combinations in any brain approaches infinity, the number of prosters which can be learned by human beings is awesome. The potential learning capacity of the brain is much larger than what is ever used. It is possible that better teaching strategies can increase the number of prosters--i.e. can increase the number of neurons being connected through the synapses.

Hart's construction of proster theory from brain research as a way to design brain compatible education is just one possible application of brain research to teaching. The understanding of how the brain functions is increasing. Better information about the brain can undoubtedly lead to improvement of the knowledge base in teacher education.

It appears also to be the case that behaviorism is not particularly a brain compatible theory. Research on the brain appears to provide empirical support for the many arguments against behaviorism cited in this paper.

SUMMARY

The knowledge base in teacher education needs improvement. Behaviorism arose because of the need of psychologists to be scientific. S-R psychology has come to dominate the knowledge base in teacher education. The first half of the twentieth century saw four interest groups--humanists, developmentalists, social meliorists and social efficiency educators--struggle for

control of the curriculum. Advocates of behaviorism allied with the social efficiency educators to control the knowledge base for training teachers.

Several thinkers have been critics of behaviorism in psychology and education including Richard M. Restak, Arthur Koestler, Bertrand Russell, Bruno Bettelheim, Elliot Eisner and Leslie Hart.

Alternatives to behaviorism include constructs taken from the philosophical works of Bertrand Russell and Karl Popper. Brain research applied to education can improve the knowledge base as can Leslie Hart's perspective which he has labeled "proster theory."

BIBLIOGRAPHY

1. Bettelheim, Bruno, Freud and Man's Soul. New York: Knopf, 1983.
2. Bobbitt, F., The Curriculum. Boston: Houghton Mifflin, 1918.
3. Eisner, Elliot, The Educational Imagination. New York: Macmillan, 1985.
4. Gould, Stephen Jay, The Mismeasure of Man. New York: W.W. Norton, 1981.
5. Hart, Leslie A., How the Brain Works. New York: Basic Books, 1975.
6. Hart, Leslie A., Human Brain and Human Learning. New York: Longman, 1983.
7. Kliebard, Herbert M., The Struggle for the American Curriculum 1893-1958. New York: Routledge & Kegan Paul, 1987.
8. Koestler, Arthur, The Ghost in the Machine. New York: Random

House, 1976.

9. Perkinson, Henry J., The Possibilities of Error. New York: McKay, 1971.

10. Restak, Richard M., The Brain. New York: Doubleday, 1979.

11. Russell, Bertrand. Education and the Good Life. London, Boni and Liveright, 1926.

12. Russell, Bertrand. Education and the Social Order. London: Unwin Paperbacks, 1977.

13. Swartz, Ronald M., Henry J. Perkinson, and Stephenie G. Edgerton. Knowledge and Fallibilism. New York: New York University Press, 1980.